OXFORD WAR MANUALS

# THE EARLY TREATMENT OF WAR WOUNDS

BY

WILLIAM ANDERSON
O B E (Mil ), M B Ch B , F R C S
*Surgeon and Lecturer in Surgery*
*Aberdeen Royal Infirmary*
*Surgeon to Municipal Hospitals Aberdeen*
*Surgical Director Emergency Medical Service*
*Northern and North-eastern Districts*

*General Editor*
THE RT HON LORD HORDER
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## FOREWORD

DURING the War of 1914–18 the OXFORD WAR PRIMERS, a series of small treatises covering a wide range of practical topics achieved a high degree of well deserved popularity among the medical profession Although certain of the more fundamental members of the series may still be found useful in their respective spheres the advances in military, no less than medical, science have been so great that an up to date series has been called for Hence the issue of the OXFORD WAR MANUALS of 1941, which, like their prototypes, proceed from the same University Press

The first group of Manuals is already planned, and three members of it are in course of production These deal with the Early Treatment of Wounds, the Treatment of Burns, and certain aspects of Wartime Psychiatry Others, designed to meet a variety of special requirements, will follow

This war, to a far greater extent than that of 1914–18, involves as potential casualties a cross-section of the whole community in medical as well as surgical emergencies Moreover, the number and variety of medical personnel engaged much exceeds that available a quarter of a century ago The present series of Oxford War Manuals is wisely planned to cover this wider field

If any good is to emerge from the evil which confronts us to day, it will be salvaged in the form of medical progress accelerated through

of experience Vital to the future stability of this hoped for gain is the adequate documentation of that hardly won experience which the Oxford series aims to encourage

HORDER
*General Editor*

# PREFACE

The change from civilian to war conditions causes a terrible upheaval in the life of the individual. While the doctor is fortunate in that he can still follow his calling as a medical man, the change of perspective is so great that, even though we have been well warned, it is difficult to accept it in its entirety. It is with the hope that the experiences of the last war (1914–18) may make this change easier for my junior colleagues, and that a record of the failures and successes in the treatment of the wounded will act as a starting point for the great advances which I am confident will be achieved [illegible] struggle, that I dare to [illegible]

[illegible]

the book written in [illegible] by my Chief, the late [illegible]

[illegible]

re[illegible]
co[illegible]
machine of war. Accustomed as he has been to [illegible]

houses, &c, and why should he inspect men's quarters, dinners, and so forth? It takes some little time for one to realize that all those duties *are* essential if the unit is to run smoothly and well in times of stress and that even the application of a Thomas's splint by numbers is, when training orderlies and stretcher bearers the only efficient and fool proof method Again it is galling to realize

claims as doctors may be brushed aside in favour of more important considerations At the same time, as Mr Henry Wade says Military discipline must not sterilize personal initiative' The administrative and the professional points of view must be blended and harmonized to the advantage of the wounded man who so thoroughly deserves better than the present best What at first sight may seem to be impossible can by a policy of 'give and take' and mutual understanding be made not only possible but practicable Let there be criticism, but let it be balanced and constructive

WILLIAM ANDERSON

ABERDEEN
*April* 1941

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## CHAPTER I

# SURGICAL TREATMENT AT ADVANCED UNITS

The treatment of war wounds is in the vast majority of cases, operative, and therefore it must be the aim of all attached to advanced units to transport the wounded man as quickly and as comfortably as possible to the unit where surgical treatment and nursing can be carried out

The reason for speed is that infection in the wound track may spread so rapidly and so exten- [illegible]

rendering the patient quite unfit to stand surgical treatment, and may even turn the scales between life and death These axioms being granted, it is quite unnecessary to stress the great importance of the work which is carried out by the regimental [illegible]

C

visualize the adverse conditions under which he will be called upon to discharge his duties during a big [illegible]

whelming Now is the opportunity to display

qualities of coolness, common sense and adaptability, for only by so doing can order be restored, at any rate, to a workable degree The principles of surgery are the same in all situations but circumstances may call for such alterations and changes that no two methods of handling the situation can be similar This is sometimes forgotten when criticism of advanced unit work is offered by those farther down the line Let everyone aim at the ideal realizing that seldom can it be reached

**The importance of preventive work** The influence of efficient early treatment cannot be over estimated The fate of a life or a limb is often determined during the first hour long before the wounded man arrives at the casualty clearing station It is only by the closest liaison and inter communication between the front and back areas that efficiency can be attained The three enemies' to be overcome are Shock Haemorrhage and Sepsis

**Shock** The problems of the causation patho

stages were carried out In spite of all that has been done and written the pathology of shock is still imperfectly understood Shock may be defined as a depression of all the vital functions of the body It is characterized by a rapidly progressing fall of blood pressure due in part at least to a reduction of the blood volume The most obvious cause of this is haemorrhage but the loss of blood in some cases is not commensurate with the degree of shock Where external haemorrhage is slight or absent, the

reduction of blood volume is due to stasis of blood in the capillaries the patient bleeds ...
vessels
perfect m
acidosis

The clinical features of shock may appear within a few minutes and become rapidly profound, while at other times symptoms may be delayed for some time and develop insidiously These conditions have been named primary and secondary shock. The pathological processes are probably similar but the aetiology is different In primary shock nervous influences and profuse haemorrhage are the causative agents while in the secondary variety exposure to cold trauma fatigue, or persistent oozing of blood are the initiating factors

and closes his eyes The face is pale with some cyanosis of the lobes of the ears and of the finger tips and nail beds Beads of perspiration appear on the forehead The pulse is soft, rapid and, later, irregular Respirations are slow, sighing, and, as the condition advances become irregular The surface temperature as felt by the hand will be found to be lowered, especially at the periphery—ears hands, and feet The rapid fall of blood pressure so characteristic of the condition, can only be accurately estimated by the aid of a sphygmomanometer, but under battle conditions this examination can seldom be carried out

**Treatment** The treatment which can be carried out at an advanced post may be briefly summarized thus (1) lower the receptivity to painful stimuli, (2) arrest the escape of blood, (3) avoid loss of heat and any added trauma

**Relief of pain** The degree of pain suffered by the wounded man does not bear any relationship to the degree or to the extent of the wound Appreciation of this point is important otherwise an erroneous estimate of the condition may be made and a proper look out for signs of shock in a lightly wounded man may not be kept Unfortunately, pain is a purely subjective sign but it is none the less important Morphia or better still omnopon if available must be our standby for this purpose Morphia is known to depress the vital centres and is also said to depress metabolism It is difficult, or impossible to estimate clinically to what extent the drug augments the depression brought about by the wound and its complications and we must be influenced by the inaccurate method of clinical impression My feeling is that the depressing action of morphia has been over emphasized and that the relief of pain and anxiety which it gives more than compensates for any deleterious effects This was borne out by the Crile treatment of penetrating abdominal wounds when large and frequently repeated doses of morphia were given for a week or more without obvious depressing effects Omnopon is less depressing but must be given in larger doses two thirds of a grain being equal to one quarter or one third grain of morphia It is well to remember that much of the benefit of a sedative is lost if the patient is at once sent off on his journey down the line An interval of at least

fifteen minutes should be allowed for the drug to take effect

Effective splinting of the injured part also relieves pain and prevents shock The universally recognized benefit obtained by the application of Thomas's splint in front line units for cases of fractured femur, introduced by Sir Henry Gray in 1917, bears testimony to the importance of this procedure

The use of a general anaesthetic (chloroform or ether) is to be avoided except under exceptional circumstances Apart from delay in elimination, general anaesthesia predisposes to shock and to a rapid loss of body heat Instances occur where the calls of humanity demand its use, but one must be certain that the advantages outweigh the many disadvantages

**Treatment of the wound.** It has for so long [illegible]

attempt to carry out an elaborate cleansing or 'disinfecting' of the wound Apart from the removal of gross fragments of clothing, mud, and missiles, nothing more than the application of a dry dressing, supported and kept in place by an even, firm bandage, should be done I realize that this [illegible]

**Arrest of haemorrhage** Loss of blood is a frequent cause of shock and continued loss aggravates the shock already present The arrest of haemorrhage at the earliest possible moment is therefore of prime importance

An obvious small spurting vessel should be caught by an artery forceps and the vessel ligatured by linen thread the ends of which should be left long It is not essential to sterilize the thread before use but if a spool which has been previously boiled is available the doctor will be happier In some cases it will be necessary to leave the forceps on and this should be done even at the risk of a strafe' for the loss of instruments When the large vessel of a limb has been injured the only hope of saving life is by the use of a tourniquet Much has been written regarding its dangers such as rupture of the vessel and death of the limb distally but our first consideration must be the life of the patient Use as wide a tourniquet as possible apply it as close to the upper limit of the wound as possible and loosen it after fifteen minutes to see if the bleeding has been arrested Decision on this point may be difficult While it is true that the brief

rrest bleeding it

will recur as the

especially if he

becomes restless As the case must pass rapidly out of the doctor s control it may be a wiser policy to reapply the tourniquet and risk injury to the tissues rather than another haemorrhage which may prove rapidly fatal

**Warmth** Of the many lessons learned in the last war none was more striking and more life saving than the realization of the terrible rapidity

with which a wounded and shocked patient loses body heat and how essential it is that means to prevent this should be instituted at the earliest possible moment The regimental medical officer should therefore impress on his regimental stretcher-bearers how important it is to preserve body heat

**Blankets.** The chief protection against the loss of heat lies in the liberal use of blankets In times of great stress the ideal of three blankets to each stretcher case may be impossible of attainment, but

by

the

practice may be universal and that the maximum advantage may be obtained from the blankets the following routine should be adopted and adhered to

and

the

clean and prepared stretcher Two blankets are

tion occupied by the pillow Blanket beneath the pillow is wasted

The wounded man by this arrangement

has four thicknesses of blanket beneath him and two on top If his jacket has been removed, or if he has an overcoat, it is laid as an extra covering over his feet. In rainy weather a mackin-

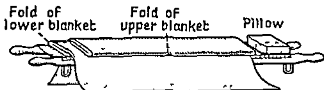



Fig. 1. Stretcher ready to receive patient.

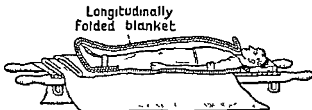



Fig 2 Method of blanketing patient

tosh sheet is added to protect him from further wet. On arrival at the advanced dressing station, or before leaving the aid post, if the supply permits, a third blanket is added The portions of the blanket wrapped round him are undone and the third blanket, folded along its length, is placed over him (see Fig 2) The lower extremity of this is tucked well in beneath the man's feet and the two corners brought round and secured above the legs by a safety-pin After the addition of the third

This method of using blankets has three advantages (1) By having a routine procedure, to be employed in every case, there is less likelihood of men being evacuated insufficiently protected

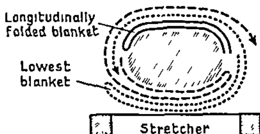



FIG 3 Sagittal section of blanketing.

against cold (2) The maximum benefit is obtained by using blankets in this manner. (3) Blankets so adjusted do not work out of position in the way they do when other methods are employed.

An adequate supply of dry, clean blankets in the reception-room of the casualty clearing station must be in readiness to replace those brought in from advance units When the supply of blankets was well organized, the improvement in the condition of the men admitted to a casualty clearing station in cold, wet weather had to be seen to be appreciated

The use of hot-water bottles would also be advantageous but can rarely be carried out owing to the limited supply of hot water. At the first suit- [illegible] application [illegible] the resus- [illegible] This need [illegible] plan is two

trestles on which the stretcher is laid, underneath which an oil stove or primus stove, burning slowly, is placed The sides—from the stretcher to the floor —are draped by blankets so that there is a heated chamber under the patient and he is warmed from below To minimize the danger of setting fire to the over hanging blankets the stove should be placed in an oil drum in the side of which a hole has been cut to allow of the free ingress of air (see Fig 4) The application of heat under a cradle placed over the patient is not so efficient as when its source is under him It is essential that a careful watch be kept as over heating which may occur rapidly and insidiously may lead to loss of fluid by sweating and rapid spread of infection in the wound

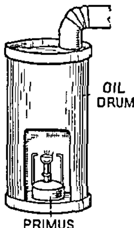


FIG 4 Stove for hot air bath

**Administration of fluids** In this connexion it is to be remembered that the giving of fluids freely to a patient suffering from cold may bring on vomiting which may be difficult to control The administration of fluids except in very small quantities should not be commenced until *after* the patient has been warmed Tea with plenty of sugar is the most acceptable and most easily prepared of all available fluids and is less likely than cocoa or meat extract to give rise to vomiting

In certain cases where vomiting is a prominent

symptom, or where the patient's condition precludes the administration of fluids by mouth, alternative methods must be found The three available rout s are rectal subcutaneous, and intravenous, and the fluid is given in the form of 0 9 per cent sodium chloride solution, or 5 per cent glucose in saline solution

**Rectal salines** These have the advantage over the other methods in that they can be administered without the risk of accidents from lack of aseptic precautions If the rectum is loaded, or if the patient is restless and semi conscious, fluids will not be retained It also takes some time for the fluid to be absorbed so that the field of application of this form of treatment is limited

[illegible]

thigh muscles, is to be recommended

**Intravenous injection.** In many well protected and well equipped advanced dressing stations [illegible]

minutes being taken to introduce a pint The temperature of the fluid is of little importance if the administration is carried out slowly To avoid untoward reactions it is essential that the fluid used be prepared under well controlled conditions and forwarded to advanced units in properly secured bottles ready for use

**Transfusion of blood at advanced dressing stations** During the last war blood transfusion was successfully carried out in field ambulances, but only to a very limited extent With the newer methods for storing and transporting blood a much wider use of this method of treatment will be made The giving of blood does not require any very special knowledge or technique but a proper selection of cases must be made in order to prevent wastage The recently introduced administration of stored serum or plasma promises greatly to simplify the treatment of shock, especially in advanced units

**Stimulants** These are mentioned only to be condemned Of the drugs used as stimulants in civil work strychnine digitalin camphor, adrenalin were all tried and found wanting In fact, they [illegible]

cannot be too strongly made as the temptation 'to do *something* is difficult to resist

**Application of splints** Perhaps the most frequent cause of delayed' or secondary shock is the presence of an inadequately supported fracture Repeated painful stimuli from the grating of the fractured ends absorption of toxins from the damaged soft tissues and the risk of fat embolism,

militate strongly against even the most robust constitutions It is therefore of supreme importance that adequate fixation of a fractured bone be carried out at the earliest possible moment During the tedious days of training the budding regimental medical officer may fail to realize how vital is the training of the regimental stretcher bearers They, less than he can appreciate the importance of their work, but in action so much depends on the efficiency of the team and so much trust is placed in them by their fighting comrades, that time and trouble spent in practice and re practice cannot be considered wasted Patience and confidence on the part of the regimental medical officer will surely have its reward on the battle field

moment

adjustment with the least possible disturbance to the patient It should be remembered that the

'setting' of the fracture does not require elaborate technique nor profound knowledge It consists of restoring the alinement of the limb by steady, firm

patient during transport the following three points must be attended to (1) adequate fixed extension, (2) adequate support for the wounded part, and (3) prevention of rotation

The minimum amount of bandaging must be done so that readjustment of the splint is readily possible The use of tapes with buckles or straps of adhesive plaster will be found efficient Care must be taken that these things do not constrict the soft parts and act as inefficient tourniquets Whenever possible the splint should be applied, and

as a sling, and a many tailed or triangular bandage to fix the arm to the chest Fractures of the shaft are difficult to control especially if comminuted Depage s humerus splint (see Fig 5) and Jones's extension humerus splint (see Fig 6) will be found to give a moderate extension and are most comfortable if the patient can walk The Thomas's splint for arm, with or without hinge (see Fig 7), gives better extension by a clove hitch round the wrist, but care must be taken *not* to apply the extension too tightly, otherwise the ring will compass the axillary vessels and cause extreme vascular

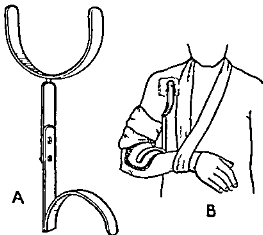



Fig 5 (a) Depage modified humerus splint
(b) Splint applied

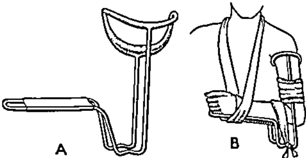



Fig 6 (a) Jones's humerus splint (b) Splint applied

interference when the arm is brought down by the side as is necessary when the patient is loaded on to an ambulance

*Fractures in the region of the elbow joint* Fractures involving the elbow joint are best supported by an internal angular splint The arm and forearm pieces should be guttered connected by two iron pieces and the joint controlled by a thumb screw so that it can be adjusted rapidly to fit either the

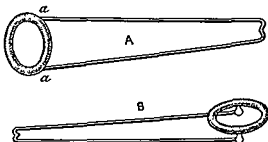



Fig 7 (a) Small Thomas s splint for arm (b) Small Thomas s splint with hinge

right or the left arm As extension is not necessary, it is better to apply the splint *after* the wounds have been dressed

*Fractures of forearm wrist and hand* Unless the displacement is gross splints are not required and
iternal angu
in fractures
own a short
anterior splint extending to just above the hand and a longer posterior splint extending from the elbow to the knuckles may be used If the splints are made of wood and are flat they should be wider than the diameter of the forearm otherwise constriction of the soft parts will occur

*Fractures of the femur* The only efficient splint

for controlling these fractures is Thomas's knee splint The outfit consists of

1 Thomas's knee splint
2 A posterior supporting splint (Gooch's splinting 26×5 in, a wooden 'Ham' splint, or Jones's metal gutter splint)

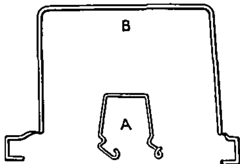



Fig 8 (a) Foot piece (b) Stretcher suspension bar

3 A short anterior splint for the thigh
4 A strong wire foot piece } (Fig 8)
5 Two stretcher suspension bars }
6 1 in adhesive strapping and bandages 4 and 6 in
7 Heel clips

The splint should be applied without removing the trousers or boots

1 Prepare a fresh stretcher for the reception of the patient

2 No 1 assistant stands at the foot of the stretcher facing the patient and grasps [illegible]

effort, for the time required for the rest of the manœuvre No 2 assistant supports the injured limb above and below the fracture

3 *Application of the extension* A steel clip fixed into the heel of the boot, if available, is the most comfortable form of extension but efficient extension by means of a clove hitch may be attained This is slipped over the boot, assistant No 1 re

applying it
nust on no
The clove

hitch must encircle the ankle of the boot very loosely Both ends of the clove hitch are placed over the external malleolus but the longer end must be resting next the boot This long end is then carried under the instep and through the loop at the internal malleolus This produces an extension band on each side of the ankle The clove hitch now passes obliquely over the dorsum and behind the heel of the boot

4 The operator threads the ring of the Thomas's splint over the foot No 1 assistant relaxing his

the notch at the end of the splint, one passing from above and the other from below Traction is made and the ends tied

5 Clothing is then cut away from the site of injury and the wound is dressed

6 The posterior splint is held in position by assistant No 2, and slings applied to keep it against the limb These slings are made of flannel or folded triangular bandages passed round the inner bar,

the foot in the stirrup a narrow bandage is passed under the heel and the ends coming up inside the extension bands are crossed and carried round the stirrup and tied opposite one of its vertical bars.

8 A piece of wood or nail is used as a Spanish

prepared stretcher

10 *Suspension bars* These are fixed to the stretcher and to them is slung the splint by four bandages (see Fig 9) The upper suspension bar prevents slipping of the ring over the tuber ischii and provides greater comfort in travelling The splint should be allowed to swing freely Apart

operating table

When the patient is picked up on the field a

effort, for the time required for the rest of the manœuvre No 2 assistant supports the injured limb above and below the fracture

3 *Application of the extension* A steel clip fixed into the heel of the boot, if available, is the most comfortable form of extension but efficient extension by means of a clove hitch may be attained This is slipped over the boot assistant No 1 relaxing first his hold by the left hand, reapplying it and then relaxing his right hand He must on no account relax his control of the fracture The clove hitch must encircle the ankle of the boot very loosely Both ends of the clove hitch are placed over the external malleolus but the longer end must be resting next the boot This long end is then carried under the instep and through the loop at the internal malleolus This produces an extension band on each side of the ankle The clove hitch now passes obliquely over the dorsum and behind the heel of the boot

4 The [illegible]
splint o [illegible]
hand gr [illegible]
slightly [illegible]
until it [illegible]
'fork' The extension bands are then passed round the notch at the end of the splint, one passing from above and the other from below Traction is made and the ends tied

5 Clothing is then cut away from the site of injury and the wound is dressed

the bleeding point will control the haemorrhage Hair should be cut short It is a waste of time to persist in attempts at shaving the scalp of a semi-conscious and restless patient This can be much more efficiently done when he has reached the operating theatre, and is under an anaesthetic If lacerated brain is escaping, the only thing to be done is to apply a moist dressing To prevent lateral movements during transport sand bags or extra pillows should be placed on each side of the head

**Wounds of the chest** Many of these cases are rapidly fatal due to massive haemorrhage into the pleural or precardial spaces Through and through

'sucking' wounds of the chest suffer severely from shock owing to the mediastinal shift towards the wounded side These wounds call for immediate temporary closure by suture or 'corking' the wound with gauze fixed by strips of broad adhesive plaster The relief of symptoms is almost immediate The question of evacuation of chest injuries is sometimes difficult If there are facilities, the retention of such cases for even an hour or two, especially when shock is present, will greatly enhance the patient's chances of recovery

**Abdominal wounds.** These cases should be evacuated as soon as possible It must not be forgotten that wounds of the lower chest, buttock, back, and upper thigh are often associated with intra abdominal injuries, and signs of this complication must be looked for It should be remembered also that rigidity and absence of free movement

are important signs, and that tenderness is more conclusive evidence than pain Morphia should not be withheld from these cases, but a note of the time

every case of abdominal injury to travel—it may

giving of morphia

Fluids should be given sparingly, and if the reason for this is explained to the patient he will, in most instances co operate

# CHAPTER II

## WORK AT THE CASUALTY CLEARING STATION

The most important lesson of the war of 1914–18 was the necessity for treatment of a war wound at the earliest possible moment, and as a result the casualty clearing station evolved and expanded to its present important position. As in more advanced units so also in casualty clearing stations professional desires cannot always be satisfied as one would wish owing to many considerations connected with the military situation.

The congregating of three or more casualty

that an ever increasing number of wounds were dealt with before massive infection had obtained a stranglehold.

The supply of essential aids to diagnosis and treatment

lingly undertaken by those in charge of administration. The planning of the hospital to allow of rapid emptying and re-equipping of ambulances with fresh blankets, stretchers, and splints added greatly to the numbers which were efficiently treated. Once into hospital the patient moved by stages from the reception room towards the evacuation

siding whether through the pre operative, resus citation, or operating tent, or, if he were more fortunate, to the tent for immediate evacuation By such organization and whole hearted co opera

Their duty was to save life, limb, and function

the range of ordinary shell fire Apart from the danger of injury, the mental effect on the helpless wounded man of shells or bombs bursting in the neighbourhood cannot be disregarded The site must be chosen where roads from the front, passable for ambulances, converge, where there is a good water supply and where there is easy evacuation by ambulance train The ideal site may quite well be impossible for other military considerations The sites for the various groups should be so chosen that one group can take over the work of another to allow it to move as the position of the front line changes

The importance of warmth to a wounded man has already been emphasized The casualty clear ing station is looked upon by the wounded man as the first haven of rest, and that haven must be warm The temperature of the reception room, evacuation room, and other wards is little less im portant than that of the operating theatre

*Grouping of casualty clearing stations* Groups of two to four were placed in one site They admitted

batch came along Two sitting cases were looked upon as equivalent to one lying case On occasion a group may be detailed to admit a certain type of injury, e g abdominal, head, or walking cases

Organization within the casualty clearing station *Reception room* Ambulance cars drive

switch Special care should be taken that the blankets have been thoroughly dried, and for this purpose wooden frames on which blankets can be hung, and stoves to provide heat, are very efficient

operating theatre.

*are the most important* in the casualty clearing station and should be men of sound judgement and experienced in base as well as in casualty clearing work One medical officer can supervise four to eight tables provided that one good nurse or nursing orderly is detailed for each table It is preferable to deal with walking wounded in a
been
The
mber
*coming in* by the *time of departure of the next* ambulance train and by its likely time of arrival at the base

Severely shocked cases will not be handled at this stage unless there are signs of external haemor rhage nor should fractured limbs be interfered with Having made his decision the medical officer sees that the cases are re dressed and if necessary re splinted that anti tetanic serum has been given as evidenced by the Field Medical Card and that a suitably marked or coloured label is attached to the man s tunic to indicate his disposal

Cases may be classified as follows

(*a*) Evacuate sitting
(*b*) Evacuate lying
(*c*) Pre operation ward
(*d*) Resuscitation ward
(*e*) X ray and pre operation ward

(*a*) and (*b*) are transferred to a ward near the railway siding Their clothes are not removed unless they are wet food and drink are supplied and the waiting period made as comfortable as pos sible The experienced sister in charge of the ward immediately informs the medical officers if a case

develops any unforeseen complication, but a personal visit should be made to the ward before evacuation takes place

(c) *Pre operation ward* Here the patient is undressed, washed and put in warm appropriate clothing Wounds should not be interfered with and splints should not be removed Cases requiring immediate operation should be specially marked by the admitting officer e g tourniquet case', 'abdominal case' The officer in charge, or at times the sister, will arrange for the patient to be taken to the theatre as quickly as possible

(d) *Resuscitation ward* The evolution of this ward is shown by the fact that in the early days of the war it was called the 'moribund' ward It was found that with careful nursing a fair number of these apparently hopeless cases recovered, and

an important part of the unit

A team consisting of medical officer and assistants, together with a sister and nurses, should be specially selected for this life saving work The equipment must be adequate Warmth, absolute rest sedatives, and transfusions of various kinds are the remedies on which reliance must be placed. Emphasis has already been placed on the importance of fluids I would plead for sound and discriminating judgement in the administration of fluids intravenously Some cases will recover without this aid, while others are so seriously ill tha little or no hope can be entertained for their re covery *'To do something' may be not only* waste ful but harmful Of the various fluids recommended

the first consideration should be given to normal saline solution or 5 per cent glucose These may be given either by the subcutaneous or intravenous routes The former is not recommended except under exceptional circumstances It may be painful absorption in a badly wounded man is too slow and there is a very real danger of the devitalized tissues becoming the site of infection—streptococcal or by gas gangrene The intravenous method is more reliable less painful and can be carried out with ease in a casualty clearing station The fluid should be run in by the drip method at first fifty to sixty drops per minute and after the first pint has been introduced the rate is reduced to thirty or forty drops per minute

**Intravenous injection of 6 per cent gum acacia solution** Although this means of replacement of fluid has received authoritative support I believe that any advantage it may have in the prolongation of the time in which the blood volume is maintained is more than countermanded by the dangers of
danger of
kidneys D
in whom the variants are so numerous both as regards the patient s resistance and the extent and severity of the injuries it is impossible to assess accurately or scientifically the merits or demerits of any form of treatment From clinical observation for what it is worth I heartily agree with Surgeon Rear Admiral G Gordon Taylor in his condemnation of this method of treatment

**Blood transfusion** The ever extending use of this form of treatment in the war of 1914 18 was dramatic but even by the end perfection was not

attained We now know that the universal donor' was a myth and I have no doubt that much harm and even the acceleration of death resulted from our well meaning efforts Direct cross typing under war conditions is impossible and it still remains to be seen how far the introduction of blood banks will help to solve the problem It is receiving the attention of many well equipped scientific workers, and I have every confidence that a reliable work able method of replacing the lost blood will be available very soon An Annexe for the preparation of fluids and their storage will add greatly to the ease of working and the efficiency of the unit

**Operating theatres** Large huts capable of accommodating four to six teams with two tables each will be found to be the most convenient and economical from the heating and lighting points of view Space for free movement of stretcher bearers should be provided and easy communication with the X ray department is essential

An Annexe for dressings and towels sterilizers,

**Sterilization of rubber gloves** The usual methods of boiling or dry sterilization have been found unreliable if contamination by spore bearing organisms has taken place The most reliable

used gloves are clean and intact Sterilization by

boiling, and the using of one pair of gloves for several cases, with scrubbing in some strong disinfectant between cases, will be found to be the most effectual and workable method

written on the Field Medical Card A coloured card indicating whether the patient is to be detained or evacuated by the first available hospital train should be attached by the clerk to the patient's clothing as this guides the bearers to the proper ward The clerk must also see that the bag containing the patient s personal belongings leaves the theatre with him

Wards The work and responsibility of the team in charge of the post operative wards is colossal, and post operative sickness, the relief of pain and

must be reapplied and a continuous watch kept for the development of gas gangrene Before evacuation every patient should be seen It is almost unbelievable how rapidly (within a few hours) a patient who is apparently doing very well, will pass into a most critical condition due to the development of gas gangrene As often as is possible the operating surgeon should visit the wards and see for himself how his patients are faring

# CHAPTER III

## PRINCIPLES OF TREATMENT OF WOUNDS AT THE CASUALTY CLEARING STATION

At the beginning of the war of 1914–18 most surgeons were strongly imbued with the faith that antiseptics provided all that was essential for successful treat-

virulent this new sepsis was, and how impotent were standard antiseptics to stay its course The *Cl Welchii*, together with streptococci of different strains, were found to be the causative organism.

As in every other war it was found that the old

it en-

new

and

renamed Gradually a treatment was evolved which had as its basis an attack on the dead and lacerated tissues These, acting as inaccessible

spread of the invading organism The 'dug out' must be destroyed, and only in one way is this possible—by excision with a sharp scalpel In retrospect it seems rather sad that such obvi

reasoning should have been so long delayed, and we can only plead conservatism, and an intense desire to avoid adding to the terrible mutilation which confronted us The treatment by excision of war wounds came slowly and universally as an evolution affecting each individual surgeon as the

solution acting on the osmotic pressure principle Organisms were washed out of the tissues by the flow of lymph and this idea was elaborated by Sir Henry Gray by the salt pack Later liquid paraffin was substituted for the salt but to satisfy the gods of our forefathers acriflavine (1 1,000), brilliant green (1 500) iodoform (1 100) were added Various pastes such as B I P were smeared on the wound surfaces although their antiseptic powers have been seriously questioned All gave improved results because the two essentials of wound treatment were observed viz removal of dead or dying tissue and rest Apart from the tissue surrounding the track which has been killed by the missile, death results from arrest of the blood supply caused by division or contusion of the nutrient arteries, or from their occlusion by pressure This pressure may come from within the limb, e g haemorrhage, inflammatory oedema or distension by gas, or from without—too tightly applied bandages, badly applied splints and of course a tourniquet An insidious cause of external pressure is a roll of gauze ... manner ... ry it ... r be ... inks'

causing constriction of the enveloped limb. Unless this danger is appreciated, extensive and irreparable damage will be done. One has only to deal with a few cases of multiple small injuries of the limbs to realize how great is the temptation to use a roll of gauze in the manner described, and yet we must remember to resist it.

The wound of the skin is not a danger and therefore only the obviously dead edges should be excised. Soon after the introduction of this method of treatment, a wide excision of skin was practised and this involved quite unnecessary sacrifice of covering tissue. The deep fascia should be freely excised, as its blood supply is poor, and sloughing is likely to follow, especially if tension due to haemorrhage is not relieved. The disability due to future herniation of the muscle should not deter the surgeon from freely incising the deep fascia upwards and downwards in order that the underlying muscle should be thoroughly inspected. In dealing with muscle while every attempt should be made to remove *dead* muscle, excision of living muscle should be avoided. In wounds seen soon after infliction the absence of haemorrhage, when the muscle is cut, and also the absence of contraction when it is cut or pinched by forceps, is evidence that the muscle is dead. Within a few hours after

ample of this is seen in the case of a wound in the upper thigh involving the upper part of the sartorious muscle. The blood supply being cut off, the

whole muscle, to its insertion into the tibia, will die If gas gangrene is to be avoided the whole of the affected muscle must be removed The situation may be summed up by stating that gas gangrene will not develop in tissues in which there is a vigorous circulation of healthy blood In carrying out the excision operation another important point must be kept in mind If the excision is made at the distal parts first blood vessels supplying the tissues left behind may be cut across in removing the proximal parts of the wound The organisms left in the wound may find a suitable nidus in the devitalized distal tissues and later give rise to gas gangrene The infecting bacilli will also develop in blood clot although much less readily and it is therefore necessary that it also should be removed from all recesses of the wounds of the soft parts

It is not always possible to carry out the ideal of complete wound excisions The track of the wound may be such that in order to give the necessary exposure important structures such as main blood vessels nerves &c would have to be divided. Under such circumstances one should capitulate and endeavour to make as thorough a removal of the lacerated muscle and fascia as is possible Where compound fractures are encountered, conservatism must also be practised The presence of dead bone although it leads to delayed healing, does not lead to the development of the deadly spreading infection as does the presence of dead muscle tissue Only completely detached bone fragments should be removed and doubtful fragments left in position

**Removal of foreign bodies** It is a counsel of perfection to say that *all* foreign bodies should be

removed as soon as possible As a matter of fact, whether they should be removed at all, and the necessity for their early removal, depends on their size, shape, and character, and also on the mobility of the part in which they are lodged and their probable effect on function The amount of damage done to the tissues depends on the shape and roughness of the missile An undistorted rifle-bullet is much less likely to cause trouble than shrapnel balls or, more particularly, fragments of shell casing It may quite often be observed that an undistorted rifle bullet lodged in the condyle of the femur will cause no trouble, while a small shell fragment lodged in the belly of a muscle will almost certainly cause sepsis If the foreign body is lodged near a pulsating vessel the danger of a secondary haemorrhage is very real From what has been said it is evident how essential is the necessity for guidance by X ray in this important problem The prolonged searching for a foreign body or bodies in a recently wounded man is to be deprecated and more courage is shown in giving up 'the hunt' than in persisting

When the 'toilet' of the wound has been completed, the decision as to whether it should be sutured or left open has to be made *Early experience* of the results of immediate closure of wounds in the last war were so uniformly bad—due to incomplete operation—that it became a rule that no sutures should be inserted The wounds were

plain—and some days later removing the pack and suturing the wound In some cases, e g amputations

primary suture of the wound was practised with satisfactory results One must not sacrifice useful length of stump to satisfy the ambition to obtain primary union The experiences of Trueta and others have shown us that excision and primary suture of war wounds is not only possible but desirable *if* the case is seen early and if the proper technique can be carried out Only experience in the present war will show how far this is possible Much depends on the nature of the fighting, the facilities for rapid transport and the number of wounded to be dealt with by the available teams Until further experience is gained it will be safer to aim at delayed primary suture

**Splinting** The importance of adequate fixation of the wounded part cannot be too strongly emphasized During the last war, plaster of Paris casing was not used extensively in fact, there was a very strong feeling against its use Since then, however the works of Winnett Orr and Trueta have demonstrated beyond doubt how useful a part this treatment can play in maintaining position and *in ensuring a much more comfortable means of* transport for the wounded man It is recommended that a skin tight plaster be applied and that it should immobilize the joints above and below the wounded area The case must however be closely watched especially if the excision of the wound has

place
such
and

an increased watery discharge from the wound, will occur unnoticed and one must rely on the general toxic symptoms—an increasing pulse rate, pale anxious expression sweating, &c The patient often falls into a deceptive sleep, and when wakened shows signs of mild delirium If the surgeon is in doubt, he should refrain from enclosing the wounded limb in plaster and use instead a plaster of Paris slab splint or one of the splints already described under forward area treatment

**Anti-tetanic serum** No matter how insignificant the wound, every patient *must* receive a prophylactic dose of anti tetanic serum If doubt exists as to whether this has already been done, another should be given In the case of a man wounded for the second or third time it is safer to give it in fractional doses, noting any local reaction In all seriously infected wounds the administration should be repeated every seventh day until the wounds are clean It is only very rarely that tetanus will be seen in the forward areas, except when it develops in a case where the wound has been so slight that the patient has failed to report its occurrence In such a case large doses, 60–100 thousand units, should be given intravenously and repeated the following day Careful nursing to maintain nutrition and to procure rest, helped by the administration of large doses of hypnotics, such as potassium bromide and chloral hydrate or, in more resistant cases, avertin, is of the greatest importance.

**Anti-gas-gangrene serum.** How far the use

**Drugs of the sulphonamide group** We hope for very great help from this recently introduced form of therapy, and without doubt we shall not be disappointed Time alone will show how far the surgical procedures recommended will be modified by their use It is doubtful however if their marvellous curative powers against organisms inhabiting living tissues can be expected to act against organisms in dead tissue

**The treatment of late cases** It is impossible to lay down a fixed time in hours to mark the passage from an early to a late case Some men have succumbed to acute gas gangrene within twelve hours of the reception of a wound while in others, after two to three days of complete inattention, little or no sign of infection may be present The surgeon must therefore be guided by the appearance of the wound and by the general condition of the patient Where it is felt that sepsis has obtained a hold the aim of the surgeon is still to remove dead tissue to relieve tension and to establish adequate drainage There can be no question of suture either primary or secondary and the enclosing of the limb in a plaster case will be fraught with danger

**Gas gangrene** As may be gathered from what has already been written gas gangrene was a new and terrible experience in the last war It had to be seen and experienced before its insidious onset, its rapid development and its deadly consequences could be appreciated It was at first a strange unknown weapon and all sorts of theories such as copper plating infected projectiles &c, were hinted at It was some little time before we appreciated that the infection was the result of the

excellent husbandry of the French peasant and that all clothing and equipment became infected by the *Cl Welchii* This anaerobe can only grow in tissues deprived of their blood supply resulting from the injury or from the action of other organisms such as the streptococcus

*Symptoms* The wound shows signs of acute inflammation It is red tender and there is slight [illegible]

On palpation the characteristic crackling of the [illegible]

and this state is followed by coma and death

*Treatment* The treatment is surgical and must be undertaken as soon as possible Wide opening up of the wound track with removal of *all* muscle tissue which shows signs of discoloration or which does not contract when cut Relief of tension by incision of the deep fascia in the part of the limb which shows the presence of gas should be carried out but incision into healthy muscles must be avoided If the main blood supply is interfered with and all the muscles below the site of injury are dead then amputation should be carried out at once The extent of the spread of gas does not influence the site of amputation For example in a case of wound of the leg with division of the

knee joint, carrie
gen anaesthesia,
hopeless case T
packed with gauze, and only one or two sutures inserted into the skin to retain the dressing

There is another case of fulminating infection which is not so common as gas gangrene In it the limb becomes swollen and tense but no gas can be palpated The patient also shows signs of acute toxaemia When the wound is opened up the whole of the tissues and especially the subcutaneous fat, are oedematous The infecting organism is the streptococcus faecalis Amputation above the oedematous area must be carried out at once

**Amputations** The young surgeon, full of his training in conservative methods, will be disappointed and shocked by the number of cases which in spite of all his care in the early treatment of the wounds will show signs of spreading infection within twenty four to forty eight hours, and at which time the question of amputation will have to be decided The responsibility of deciding between an attempt to save a limb especially a hand and arm and the risk of losing a life is indeed grave Experience will help but we know how fallacious it can be and no hard and fast rules can be given The following considerations may prove helpful

*Limb* (1) Protheses for the lower limb *are* much more satisfactory than are those for the upper limb (2) The state of the circulation distal to the wound (3) The general condition of the patient Patients who have been badly shocked even though they have apparently recovered well are less likely to resist infection than those who have not been so

affected (4) Is the wound single or multiple? If there are wounds of any severity elsewhere, amputation of the doubtful limb should be more seriously considered (5) Age Other things being equal it is justifiable to attempt conservative treatment for a little longer in the young man than it is in the old

*Type of amputation* In order to ensure drainage and to shorten the time of operation the guillotine amputation was popular in the early years of the war The exposed raw surfaces caused so much pain, and took so long to heal, that this type of amputation was largely given up in favour of flaps The length of the flaps as indicated in operative surgery books are too long, and nothing is to be gained by having a mass of redundant skin the edges of which are likely to die In advanced units, amputation through the site of fracture will often be possible and will be found to be satisfactory. The flaps, shaped as the available skin will allow, should not contain muscle The end of the bone is trimmed and vessels ligatured There seems to be difference of opinion regarding the treatment of the main nerve trunks Apparently high division does not prevent the development of painful neuromata The wound should be packed with gauze and one

profuse oozing To prevent this it is well to cover the raw surfaces of the stump with thin artificial silk, if such can be procured, and place the gauze superficially to this The silk prevents adhesion of the gauze and does not interfere with the escape of serum or of pus. Gauze impregnated with vase-

line or liquid paraffin also makes a comfortable dressing, but oozing from small vessels is apt to persist. A firm, well padded dressing is then applied and the stump firmly bandaged. It is sometimes necessary, especially in amputation through the upper part of a limb, to fix the bandage and for this purpose adhesive strapping or elastoplast may be necessary. Fixation of the stump by splints is ideal, but frequently, as in the case of the thigh, cannot be carried out efficiently. Commencing at once and during convalescence a watch must be kept to prevent flexion deformity at the joint above the amputation. The placing of the limb on a pillow, although comfortable, must not be maintained continuously, otherwise flexion deformity very quickly develops.

*Drainage and kind of drain.* Discussion has raged, and still rages, as to the type of drain which permits of the escape of wound discharges. If the wound has lent itself to satisfactory surgical cleansing the insertion of a drainage tube, whether made of rubber, glass or perforated zinc, is unnecessary. Where, however, an abscess has been opened the surgeon feels bound to preserve an opening for the egress of future discharges. Jaconet, rubber dam and especially gauze do not do so as is evidenced by the fact that when they are removed a gush of fluid follows and proves that they have acted as a cork. No one disputes the rubber tube as the method of drainage in empyema thoracis, and hence it seems reasonable to advise that where a cavity exists and drainage is necessary a rubber tube will answer the purpose more efficiently than any other material. One must weigh the disadvantages against the advantages. The rubber tube

is a foreign body and causes irritation and even necrosis of the structures with which it comes in contact It should not therefore be placed in close proximity to important structures such as arteries, veins, the synovial membrane of a joint, brain tissue, &c Even in less vulnerable tissue its potentiality for danger must be recognized and its use dispensed with as soon as possible The presence of a drain does not prevent the development of a haematoma as the blood quickly clots, filling the wound and the tube

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## CHAPTER IV

# WOUNDS OF THE BRAIN AND ITS COVERING

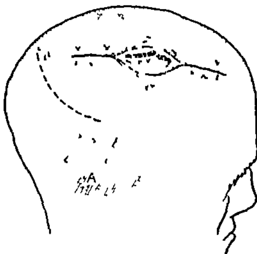
If the wounds of the brain are left untreated until inflammation has obtained a hold the results to life and function are disastrous It is therefore of the utmost importance that these wounds should be treated efficiently at the earliest possible moment It was, however found that after operation 'brain' cases travel badly and their early evacuation is often impossible The casualty clearing stations which are to deal with such cases must therefore be equipped for the retention of a large proportion of them for some days and even two to three weeks The principles underlying the treatment of brain cases do not differ from those already stated Sepsis is best prevented by early and complete operation Foreign material projectiles and displaced bone—should if possible be removed as should dead brain tissue Wide excision of skin edges is not necessary but the wound should be enlarged to give good exposure Some have advocated the turning down of a wide bone flap for this purpose, but in the majority of cases a careful enlargement of the wound in the skull by strong nibbling forceps will be found to be sufficient The removal of bone should be carried out by the nibbling of small bites, rather than by the more rapid and shock producing method of cutting off large fragments by a strong bone cutting forceps It is well to remember that care must be taken not to further injure the already torn dura while this is being carried out Having

made an opening in the skull the size of a five- [illegible]

[illegible] Dr [illegible] [illegible]

saline solution through the catheter also helps to wash out the lacerated brain It must be done carefully and systematically and requires time and patience Rough searching for metal bodies or loose bone in the depth must be avoided A probe or ventricular needle, and very occasionally the gloved operating finger, may be used for this purpose When satisfied with the 'toilet' of the wound, the surgeon should endeavour to close the scalp over the exposed brain, inserting a small drain at the most dependent part This drain should penetrate the scalp only and must not lie in the substance of the brain Closure can almost always be obtained by enlarging the incision so as to form a sliding flap with a broad base (see Figs 10, 11, and 12) It is important to suture the galea as well as the skin, and for this purpose linen or silk thread (not catgut) should be used In times of stress one is tempted to dispense with the time consumed in the suture of the galea, but this procedure controls haemorrhage, gives an even tension in a wound which has to be closed with considerable difficulty, and may prevent a hernia cerebri during convalescence

[illegible]



Fi[illegible] ure of scalp wound, sl ow[illegible] S flap B=U flap

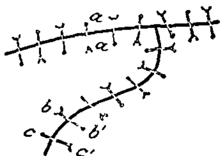



Fig 11 [illegible] peration concluded

symptoms The wound may be gutter shaped or the entrance and exit wounds may be very close If the patient gives the history of having been stunned at the time of injury it is wise to presume

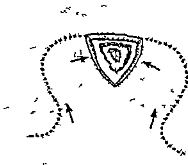


FIG 12 Diagram of plastic operation for triangular defect

that a serious intracranial lesion has occurred and therefore operation should be undertaken Some cases will be encountered where, on excision of the scalp wound, only a slight bruising of the periosteum will be seen It has been found very frequently that in this type of case an extensive comminution of the inner table has occurred In some cases a good skiagram will show the presence of a fracture of the inner table, but in others evidence will be lacking, or the taking of an X ray plate has not been considered necessary If in doubt the surgeon should make a small trephine or burr opening through the outer table and the condition of the inner table be ascertained If a

*of the dura mater* After removal of the fractured bone the dura is inspected If it is normal in appearance and the brain pulsates well, the operation is ended by closure of the scalp wound If, however, the dura looks muddy', if there is loss of pulsation and circumscribed loss of elasticity, it should be incised This is done by a small crucial incision which may be enlarged if extensive blood-clot or lacerated brain is found

(c) *Deeply seated foreign bodies* It goes without saying that it would be the ideal treatment at a primary operation for a penetrating wound if the foreign body could always be removed Otherwise the operation must be regarded as incomplete with a far greater likelihood of subsequent abscess formation than if removal of the missile has been accomplished It is equally true that foreign body extraction no matter how desirable, as a means of avoiding these possible complications should never be forced to the point of increasing the damage to the nervous tissues already done by the penetration Some say avoid infection at any cost', others better a fatality from infection than the certainty of perpetuating paralysis Between these two schools one must decide in the individual case—always extract a foreign body if it can be accomplished without increasing the damage already done This discussion applies solely to deeply implanted missiles for all agree that superficial and easily accessible ones should of course, be removed Extraction with a magnet is the only justifiable method applicable to deep seated bodies and can

often be accomplished after suction of the track in the usual method by gently sliding into it, to the proper depth, a French wire nail with rounded point Contact with the proximal end of the nail is then made with a portable electromagnet which need not be a weight greater than can be easily handled, and if the foreign body is magnetizable and proper contact secured it will be withdrawn along its own track of entry In not a few cases the missile and bone fragments have been driven through into the ventricle and in the process of suction the cerebrospinal fluid spaces have been sucked completely dry Many cases with opened ventricle when treated in this way have made perfect recoveries

to cortical irritation and not to interference with the blood flow in the sinus

Operation in such cases may be difficult on

an inexperienced operator A trephine or burr opening should be made just beyond the fracture, and, with a Montinovesi or de Velbis forceps the frac-

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cose—solution gives rise to a temporary fall in cerebrospinal pressure, but is quickly followed by a rise above the previous level In most cases of hernia cerebri careful and frequent dressing of the wound to prevent secondary infection is all that is called for. As the reactionary oedema subsides the hernia will slowly regress On no account should the protruding brain tissue be 'shaved off'

**Lumbar puncture.** This is seldom called for in brain injuries, either from the diagnostic or from the post operative points of view The knowledge that there are blood cells in the cerebrospinal fluid or that there is an increase in pressure will not carry us any farther in the diagnosis and treatment than what is already known by the history and physical signs, and, unless it is established that further knowledge is likely to help, one is not justified in carrying out a procedure which is not without some risk Such serious cases should be admitted to the resuscitation wards for observation, as occasionally an apparently moribund case will improve to such an extent that operation may be carried out later From this point of view also the apparently trivial head wounds ought to be care-

reduce convalescence by months

**Anaesthesia.** In cases of head injury, local anaesthesia has many advantages The addition of adrenalin (4–5 drops to the oz ) controls haemor-

proposed incision Cutting the bone does not cause pain, but pressure on the dura mater, or the catching of vessels in the dura, causes discomfort The mental condition of the patient and also of the surgeon are important considerations in coming to a decision If general anaesthesia is called for, the intratracheal method, which gives a free air way and therefore diminishes congestion, is to be preferred

**Preparation of the scalp.** In the reception-room a soap soak should be applied and the shaving of the scalp carried out on the operation table Previous cutting of the hair by scissors or clippers carries no advantages if a well sharpened 'cut-throat razor drawn with the lie of the hair is skilfully used A trained orderly can carry out the preparation on the spare table while the surgeon is closing the wound of the previous case In disorientated patients the shaving should be done after the patient is under the anaesthetic The extra time taken will more than compensate for the shock which follows valiant but misguided attempts to remove hair caked with blood and mud from the scalp of a non co operative apprehensive patient.

## CHAPTER V

# PENETRATING WOUNDS OF THE ABDOMEN

In the war of 1914–18 two or three per cent of the cases handled at the casualty clearing station were penetrating wounds of the abdomen, but this represents only a small proportion of the total number, as many died on the field or on the way back With increasing aerial activity, the surgeon is likely to get a large proportion of the wounded much sooner, and therefore the number of penetrating abdominal injuries is likely to increase The two lethal factors in this type of injury are (a) Haemorrhage which cannot be controlled by non operative measures, and (b) Infection of the peritoneal cavity or retro peritoneal tissue following the perforation of hollow viscera To combat these with reasonable hope of success, operation at the earliest possible moment is essential Apart from internal injuries, the wound of the abdominal wall is also a source of danger, [illegible]

anywhere in the trunk where excessive external haemorrhage has not occurred must give rise to the fear that either intra thoracic or intra abdominal lesions have occurred Unless this is remembered,

cases of this type will be missed in the early stages and treatment delayed with regrettable results

The surgeon, accustomed to the diagnosis of civil abdominal disasters, will be misled by the absence of signs, which he regarded as pathognomonic, of perforation of a hollow viscus As the small intes- [illegible]

rigidity of the abdominal muscles and even tenderness are not present except in the region of the wound Within a variable time depending on the rate of haemorrhage a peritoneal reaction does occur this is characterized by a spreading tenderness and a positive rebound phenomenon Although there may be some increased muscular resistance muscular rigidity does not appear until much later If the stomach is distended at the time of wounding and the type of injury allows the escape of its contents signs similar to those caused by a perforated ulcer will be present Perforations of the colon do not as a rule give rise to signs of early peritoneal reaction The presence or absence of liver dulness is of no value in the diagnosis, nor is the examination of the abdomen for the presence of free fluid likely to be of any help In cases showing an entrance and exit wound some help in the diagnosis may be afforded by trying to visualize the track which the missile has made Too much reliance on this method of diagnosis should not be made because the course taken by the missile is not always a straight line and also because of the varying positions occupied by the normal hollow viscera The aid of an atlas of sectional anatomy will very seldom be of value

**Radiography.** Where there is no exit wound, and where the entrance wound indicates that the missile is of considerable size, it is important to obtain such assistance as one can from X ray investigation The removal of such a foreign body from the retroperitoneal space may be imperative to prevent a fatal ending from infection, and a knowledge of its site permits of its surer and more rapid removal In cases where the missile is small, X ray examination can well be omitted It is time consuming and the transport and manipulation will only aggravate the already present shock From what has been said it will be seen that frequently the diagnosis can only be provisional and an intra abdominal lesion suspected This, however, is enough to warn the surgeon of what lies ahead and not only to warrant but to demand surgical investigation

**Treatment** *Pre operative* Shock being, in many cases, a well marked symptom, treatment by the methods already described must be instituted It must always be remembered, however, that whatever method or methods are used, haemor-

must rest on the judgement and experience of the surgeon On the whole, it will be found better to undertake operation early, and to rely on restora-

in the condition of the patient Blood transfusion is much more beneficial and more lasting in its

effect if performed *after* operation If this attitude is adopted, more cases will be operated upon, and the operative mortality rate will rise, but the chances of recovery to the individual will be increased When the patient is seen in the resuscitation ward his general condition may appear to be such as to warrant operation Merely transporting him from the ward to the operating theatre may

upon to deal with war wounds of the abdomen Both will be severely and frequently tested

**Anaesthesia** The judgement skill, and sympathetic co-operation of the anaesthetist are of immense value to the surgeon under warfare conditions For cases of abdominal injury suffering from shock gas and oxygen is undoubtedly the anaesthetic of choice but for its successful administration special skill and experience are necessary The surgeon is dealing with a progressive, uncontrolled haemorrhage of unknown location, and speedy manipulation with as little increase in shock as possible is necessary The increased respiratory rate and straining during induction may increase the rate of haemorrhage, and a light anaesthesia during the handling of the loops of intestine may be productive of still greater shock In the last war open ether following a rapid induction with ethyl chloride or nitrous oxide, was the most universally employed anaesthesia, and it gave, on the whole the best results Spinal anaesthesia was not employed to any extent and the fall of blood pressure, which frequently accompanies this

method of anaesthesia would add greatly to the risk of operation It is doubtful if the recently introduced barbiturate will be found suitable for the same reason For premedication morphia or omnopon with atropine will be found to be the most reliable

Operation Speed is the handmaid of success, but must not be achieved at the expense of rough handling or bruising of the tissues Where an entrance or exit wound is situated posteriorly e g loin, buttock or even thigh this must be excised before the abdominal incision is made This at first seems to contradict sound surgical technique, in that a 'dirty' wound is dealt with before a clean wound is made but the great fall of blood pressure which ensues if the patient is turned *after* laparotomy makes its observance imperative In some cases it is also necessary to excise the wound caused

length Splitting of the rectus muscle should be avoided as the muscle fibres *between the incision* and the midline are thereby cut off from their blood- and nerve supplies and readily become a prey to *Cl Welchii* The incision may be augmented by transverse or oblique incision if it is necessary

as the small intestine and its mesentery are the parts damaged in the majority of cases, this portion of the bowel must be

systematically ·
either at the
ileo caecal val
the site of the wounds in some cases Besides the bowel itself, its mesentery must be carefully examined for bleeding points The omentum must be inspected as must also the stomach and the colon through its whole length A retroperitoneal haematoma in the region of the duodenum or colon
peritoneum
is difficult
vious that
haemorrhage is coming from the liver or spleen In this case a large pack of gauze should be used to arrest the bleeding while the rest of the examination is carried out As wounds of the viscera are frequently multiple it is better to control the injured segment by a lightly applied bowel clamp and to proceed with the examination rather than to repair the wounds as they are discovered Having completed the examination there must be no re examination Handling causes shock and must be reduced to the necessary minimum

**Small intestine** Herniation of the small bowel through the wound in the abdominal wall, although usually accompanied by severe shock, does not mean a hopeless prognosis and it is often well worth while tackling such cases as it is unlikely that extensive infection of the peritoneal cavity has occurred

In the war of 1914 18 frequent discussions took place regarding the relative merits of suture and resection By 1918 the general opinion was that simple suture of the perforation was to be preferred in suitable cases If suture is decided upon, a single

layer of linen or silk thread is all that is necessary, inserted as a continuous suture and invaginating the pouting mucous membrane Considerable narrowing of the bowel should not cause dismay Special care must be taken when the wound of the gut is closed at the mesenteric attachment The presence of a haematoma into the mesentery makes visualization difficult, and it is frequently necessary to ligature the divided vessels and clear the bowel edge so as to make sure that a perforation, if present, is securely closed Although simple suture is the ideal method of treatment many cases will be encountered where this procedure would be disastrous on account of interference with the blood supply If bowel is separated from its mesentery for more than three quarters of an inch resection is safer than simple suture Multiple wounds within a short segment of gut may make efficient suture impossible Very numerous and extensive wounds may make suture more time consuming than resection Extensive infarct of the mesentery may demand resection on account of interference with blood supply It is therefore a mistake to make hard and fast rules The decision must depend on the judgement of the surgeon

**Anastomosis.** An end to end anastomosis in the small bowel will usually be found to be the most rapidly carried out and the most efficient method The escape of intestinal contents should be controlled by clamps and the crushing forceps should be removed before suturing is commenced [illegible] linen [illegible] teric [illegible] the loose end being left long When the anti mesenteric

called dangerous mesenteric angle need cause no anxiety if this technique is adopted One or two

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Wounds of the
oe regarded with
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ents and also to
the fact that the retroperitoneal tissue is frequently infiltrated by haemorrhage and bowel contents Infection of the retroperitoneal tissue spreads with alarming rapidity and little can be done by drainage to prevent this fatal complication The thinness of the bowel wall makes suture difficult and often insecure It is quite easy in the presence of a retro peritoneal haematoma to overlook a small perforation of the colon while bruising of the wall and interference with the blood supply may lead to late perforation For these various reasons prognosis in a ca
the abc
reveal
some cases suture of the wound will be successful, but, if the lesion is extensive if there is any doubt concerning the viability of the segment or if suture is doubtfully successful the involved segment should be exteriorized through a separate incision add a temporary colostomy performed In other cases it will be necessary to treat the involved segment by resection and this can be more safely and

more quickly performed by the two stage Paul-Mikulicz method The writer agrees with Surgeon Rear-Admiral G Gordon Taylor that resection in all but the simplest cases is the method of choice His pioneer and apparently daring work in the surgery of gun shot wounds of the abdomen in the last war was more than justified by the outstanding results which he obtained In the rush of work at

found safer than the one stage end to end anastomosis method It will also shorten the time spent at the operation which is important in patients already suffering from shock As has been said, sepsis, especially infection of the retroperitoneal space, is a constant dread, and therefore every available method of treatment to combat this must be instituted at once This will include drainage, sera, and drugs of the sulphanilamide group

**Wounds of the stomach and duodenum.** Wounds of the stomach vary in size and in site, being frequently multiple The extent of peritoneal soiling depends on whether the stomach was empty or full at the time of wounding They can almost always be closed by suture Professor Wilson Hey has shown experimentally that it is almost impossible so to deprive the stomach of blood supply as to cause gangrene or sloughing of its walls, and even very considerable deformity caused by suture is unlikely to interfere with function Wounds of the duode-

its fix

preser

calls for careful search for a retroperitoneal perfora- [illegible]

in many cases of intraperitoneal injury the lesion will be discovered during exploratory laparotomy The bladder should be sutured whenever the condition of the patient and the accessibility of the wound permit Where this is impossible a self retaining suprapubic tube should be introduced, and the vicinity of the extraperitoneal bladder wound drained

**Wounds of the liver** The type of wound found in the liver may vary from a small perforation to almost complete disruption of the whole organ In some cases the wound is so extensive that it would be impossible to prevent infection by surgical measures If the track of the missile indicates that only the liver is injured and if the signs of haemorrhage are not pronounced expectant treatment should be instituted Sir Cuthbert Wallace and the late W W Wagstaffe have conclusively shown that surgical abstention in most of these wounds is advisable When the abdomen has been opened and a bleeding wound of the liver is discovered, attempts should be made by mattress suture to control it This however is often difficult both on account of the friability of the liver and also on account of the difficulty of access In such cases it may be necessary to pack the wound with gauze If the bleeding is an ooze it is better to do nothing as frequently this will stop when the abdomen is closed A slight jaundice soon after injury is of no importance, while

an icterus, developing later in the case, is of grave significance and indicates sepsis

**Gun-shot wounds of the kidney.** All grades of ... extens... eruption

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hilum is injured or there is extensive laceration of the body of the kidney should nephrectomy be undertaken Usually it is enough to excise the parietal wound, expose the kidney for examination, and control haemorrhage by pack or suture Very frequently the kidney injury is accompanied by lesions of a hollow viscus, the treatment of which is much more urgent

**Retroperitoneal haematoma** In quite a number of cases, after the abdomen has been opened and explored, the only lesion found will be a retroperitoneal haematoma Attention has already been drawn to the importance of looking for a hidden perforation of a hollow viscus in these cases, and the surgeon must not rest until he has excluded such a lesion If none is found, no attempt to deal with the haematoma should be made Theoreti-

tissues, and any attempt to do so prolongs the ... shock The chance

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may be dealt with at a later date

**Abdomino-thoracic wounds.** Shock is an early and prominent symptom in wounds of th

class, and the mortality is high  Increasing experi

counts for many of the late deaths in those who survive the initial loss of blood and shock  When

whether the abdominal cavity has been perforated or not  The rigidity due to a chest injury is not so constantly maintained as is the rigidity of peritoneal irritation  During the abdominal examination if the hand is kept moderately firmly applied to the abdominal wall a distinct lessening of the muscular rigidity will be appreciated  This is not maintained for long but is enough in some cases, to establish the diagnosis  If doubt still exists, exploration must be carried out

**Treatment**  As a rule the approach should be by the thoracic rather than the abdominal route  The parietal wound is excised and enlarged along the course of the ribs downwards and forwards  The pleural cavity is opened up and fluid blood removed by suction  The ragged wound of the diaphragm is excised and enlarged and a very satisfactory

minal viscer

the injuries t

the diaphragm is closed using small curved round bodied needles carrying fine interrupted linen sutures  The pleural cavity is then dealt with in the manner discussed in the following chapter.

## CHAPTER VI

## PENETRATING WOUNDS OF THE THORAX

EXPERIENCES in the last war in base hospitals and casualty clearing stations led to the erroneous opinion that a 'chest' wound was the most favourable of all the various types in that a large number recovered with no greater risk than an empyema. Further experience at advanced dressing stations or regimental aid posts cast considerable doubt on this opinion, but the true mortality of thoracic wounds can be gauged only by examination of the dead on the battle field. Mr K. M. Walker quotes Sauerbruch who found that out of three hundred dead examined on the battle field 37 per cent. showed chest wounds. The obvious conclusion is that a large number of chest wounds are immediately fatal, nor is this to be wondered at when one considers the large and vulnerable organs and vessels contained within the thoracic cavity. Under the cond

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under the observation of the surgeon. In spite of the advances made in recent years in civilian thoracic surgery, and the hope that these would prove successful in many cases of chest injuries due to warfare, we must realize that the derangement of function of heart and lungs following the formation of a large opening into the pleural cavity is fatal, due to mediastinal swing. The only treatment possible in such cases is to pack the wound with dry gauze, using skin sutures to maintain its positio

and to apply anti shock treatment The patient is usually distressed, and to combat this, morphia or omnopon should be freely given Continuous oxygen administration by the B L B Mask, under supervision, also promises to be of very great help in this type of case

**Less severely wounded cases** If the patient has survived the initial haemorrhage and shock, sepsis, as in wounds of other parts of the body, is an ever present danger and in order to combat its development certain measures must be instituted.

It was found that most patients with punctate entrance and exit wounds whether due to bullet or small shell fragments recovered without operative measures *but* one and all must be carefully watched There may be little or no haemorrhage If the haemothorax does not reach higher than the nipple line and does not show signs of increasing, no anxiety on the score of haemorrhage need be maintained If however the temperature and pulse do not subside or tend to increase if there is increase in respiratory distress or if the patient shows an anxious expression then sepsis must be suspected and by the use of the exploring syringe, fluid removed for bacteriological examination A crimson-purple colour of the froth in the barrel of the syringe and a foul odour of the fluid are sufficient proof of anaerobic infection A negative finding is by no means infallible because sepsis may develop in islands or areas of the clot or fluid which are not tapped by the needle Increase in pneumothorax or development of resonance in previously dull areas should make one suspicious of gas infection, and if, in such a case other symptoms pointing to infection are sufficiently prominent, operation

should be undertaken without waiting for bacteriological confirmation In no part of the body does toxaemia of gas gangrene develop so rapidly and so fatally as in an infected haemothorax In cases of limited non infected haemothorax, treatment by aspiration is unnecessary as the fluid is usually fairly rapidly absorbed If the haemothorax is large, aspiration may be required to relieve symptoms of distressed respiration, even though no infection is present Fresh bleeding very rarely, or serous effusion, may cause increased intrapleural pressure which will call for treatment Aspiration should be done slowly and no more fluid removed than is necessary to make the patient comfortable If urgent symptoms recur it is probably best to operate at once Make a large opening in the chest wall, clear out the pleural cavity, control the source of h

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ment by air Between the two types of cases described there exists a fairly large number in which decision as to treatment is fraught with great difficulty and anxiety

**Operation** The late Professor John Anderson, D S O, classified cases requiring operation as follows

1 Wounds caused by large irregular fragments of high explosive shell which have lodged in the thorax These are almost always associated with (*a*) open 'sucking' wounds of the chest wall, and (*b*) infected fragments of clothing carried in with the missile
2 Tangential wounds of the thorax enfilading

[illegible]

3. exit wounds are explosive in character

Discussion of the extraordinary variation of the lesions which occur in the thoracic viscera is not necessary here Suffice it to say that they may be extraordinarily simple and easy to deal with or they may demand great skill and dexterity combined with ample courage on the part of the surgeon Immediate fatal haemorrhage as the result of removal of a large piece of shell from the root of the lung need not deter the surgeon keen to accept his responsibilities from tackling the next apparently similar case The heart as well as the lung, has shown itself to be tolerant of manipulation Foreign bodies in the wall or cavity of the heart have been removed with wonderful ease and success

X ray plates taken both in the antero posterior and lateral axes supplemented where thought advisable by stereoscopic views are essential before operation for localization of foreign bodies, and to indicate the extent of bony damage

**Choice of anaesthetics** Many cases can be done under local anaesthesia by infiltration at the site of incision and by the blocking of several intercostal nerves above and below the site of entry If a general anaesthetic is indicated it should be given by the intratracheal method In no branch of surgery is the closest co operation between surgeon and anaesthetist so essential On one, just as much as on the other does the success of the operation depend The ideal is a quiet induction, absence of trauma to the upper air passages, control of the

the surgeon must do all in his power to avoid unnecessary trauma and must inform the anaesthetist in advance regarding the stages of the operation With the help of an expert anaesthetist exploration of the chest causes the surgeon no more anxiety than does exploration of the abdomen

**Technique of operation** The incision will frequently be decided by the site of the wound This will be treated according to general principles by excision of skin edges lacerated muscles, and comminuted ribs Access must be adequate and this may be attained by intercostal incision without removal of lengths of normal ribs The use of an efficient rib spreading retractor is essential If the missile wound is situated over the scapula, or is high up in front of the chest a separate incision through the sixth or seventh space will be required to give efficient access Blood in the pleural cavity should be removed by suction if available, as this method causes less trauma and is more rapid than

embedded in the spine is removed, and the bed cleaned by gauze or spoon The wound in the chest wall is now completely closed by approximating the separated ribs, holding them in position by interrupted sutures of strong catgut passed through the intercostal spaces above and below the wound, and tied after all have been inserted It is not necessary to stitch the pleura, but the overlying muscles and

skin must be accurately approximated to ensure an air tight wound Fluid which accumulates in the pleural cavity during the first day or two should be removed, either by an air tight drainage tube inserted through a separate wound with resection of one inch of rib at the lowest part of the pleural cavity and led under fluid into a bottle by the bedside, or by repeated aspiration during the first days of convalescence As sepsis is a danger the former method is preferable The tube should enter the pleural cavity only for a short distance so as not to interfere with expansion of the lung It is impossible to state how long the drainage tube should remain *in situ* Much depends on the amount and nature of the discharge and on the rate of expansion of the lung which can only be estimated by repeated X ray examination Attempts to expand the lung by raising the intratracheal pressure at the end of the operation should not be attempted Immediately after operation oxygen therapy in the most suitable available form should be instituted, and a blood transfusion even when the general condition of the patient is good will be found to accelerate convalescence The following report by the late John Anderson shows how successful this treatment was in seventy four cases treated by him at a casualty clearing station in France from 2 April 1918 to 2 June 1918

Wounds [illegible] wall not opening pleura are not included in th[illegible]

| | Cases |
|---|---|
| Total number of patients with penetrating wound of chest (4 deaths occurred in pre operation ward) | 74 |
| Caused by bullet | 17 |
| Caused by shell bomb &c | 57 |

| | |
|---|---|
| Operative procedure in | 55 |
| Number of these cases with multiple wounds | 34 |
| Cases with wounds of thorax and abdomen, involving and requiring suture of diaphragm | 20 |
| Cases with foreign body lodged in lung or chest cavity | 17 |
| Foreign body removed | 14 |

The majority of cases were operated on between eight and twenty hours after wounding

*Results*

| | |
|---|---|
| Cases evacuated to Base apparently well | 44 |
| Died at Base (sub phrenic abscess and shock) | 1 |
| Required secondary drainage of empyema at base and recovered | 1 |
| Under treatment (one with secondary drainage for *Cl Welchii* and strep infection) | 2 |
| Died at casualty clearing station after operation | 9 |

*Analysis of Deaths*

| | |
|---|---|
| Chest and abdomen | 5 |
| Peritonitis | 3 |
| Septic lung | 2 |
| Infection of haemothorax caused by haemolyzing streptococcus multiple, E and E bullet (No other case of strep H found) | 2 |
| Pure chest, shock E and E bullet, involving lung and root of neck | 1 |
| Both chest cavities and cervical spine | 1 |
| One German prisoner went to base with open thorax, local | |

*Remarks* There was an unusually large proportion of shell wounds and of chest abdominal injuries

Most of open thorax cases arrived with temporary

suture and travelled well to casualty clearing station, when compared with purely abdominal cases, who travelled badly. Nearly every case required aspiration, some six or seven times.

Prevailing infection, *Cl. Welchii*.

All except two cases remained closed and required no secondary operation except aspiration.'

**Septic haemothorax.** When septic infection of a haemothorax occurs operation becomes imperative. If the general condition of the patient is good, operation on the lines above described should be carried out. In some cases deterioration is so rapid that any extensive operation is likely to end fatally, and under these conditions resection of one or two inches of the eighth or ninth rib in the posterior axillary line with evacuation of fluid and the institution of closed drainage should be performed under local infiltration anaesthesia. It is to be remembered that sometimes the diaphragm will be found to occupy a very high position in this type of injury, and it is very easy to enter the abdominal, instead of the thoracic, cavity. Should this unfortunately occur the diaphragm is immediately closed by suture and a section of the rib above and more posteriorly is removed.

**Irrigation of the pleural cavity.** This should not be carried out at the time of operation, but it is of value when convalescence has become established. It should be instituted cautiously owing to the possible presence of a broncho pleural fistula. Decision as to which of the various methods of carrying out the irrigation will be influenced by the experience of the individual surgeon in charge of the case.

**Breathing exercises.** The introduction of this

form of treatment, under skilled supervision, has done much to hasten convalescence in empyema
... nd is applicable
wounds They
patient can be
persuaded to co operate

**Surgical emphysema** Some degree of surgical emphysema occurs in most cases of penetrating wounds of the lung As a rule it remains localized and is of no significance In a few cases, however, it spreads over the whole body and may prove fatal In such cases it is advisable to open the pleural cavity and to separate the injured adherent lung from the chest wall

## CHAPTER VII

# WOUNDS OF JOINTS

In the early days of the last war wounds of joints, particularly the knee joint gave most disheartening results The same sad story of sepsis amputation, and frequently death had to be recorded in almost every case, and only occasionally after a long and stormy convalescence was the patient left with an ankylosed joint The late Sir Henry Gray immediately became interested in the problem and with his usual energy and ingenuity began to devise methods to improve these results In 1915 he laid down a line of treatment which materially changed the unfavourable prognosis and saved many useful joints

Wounds of the knee joint are more frequent, and liable to be more disastrous in their consequences, than those of any other joint Their treatment therefore receives first attention but the principles can be adapted to other joints The great improvement in the results was due to thorough treatment during the pre inflammatory stage and to careful fixation during transport The evil effects of transport are manifested to a greater degree in wounds of the knee joint than in most other types of wound

**Types of injury** Common types of injury may be summarized as follows

I Cases of effusion without lodgement of the projectile in the joint (*a*) in which it is uncertain whether the joint cavity has been traversed or whether the synovial membrane has been merely bruised, (*b*) in which the synovial cavity has been

traversed by a rifle bullet without injury to the bones In connexion with injuries of this class the frequent association of effusion into an intact knee joint with fracture of the shaft of the femur must also be kept in mind

*Treatment* Cases in this class should be treated expectantly by complete rest with moderate extension If suspicion of infection arises the joint should be tapped and the effusion examined bacteriologically If the infection seems to be mild, repeated tapping with the administration of sulphonamides may be tried under close supervision but usually it is better to open up the joint freely, wash out thoroughly with a saline solution, and to close the wound carefully again

2 *Retained missiles* (a) Missile within the synovial cavity (b) Missile retained in the articular ends of the bones

*Treatment* (a) If the retained body is a rifle bullet and the superficial wound is small it may be left for a few days the joint being meantime immobilized but the better plan is to arrange for its removal as soon as possible Fragments of shells or bombs must be promptly removed

(b) *Missiles imbedded in the bones* Rifle bullets so situated as not to interfere with the movements of the joint need not be interfered with at an early stage They may do no harm and have frequently [illegible] o
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body must be removed by the shortest and safest route This may be by the original wound althou sometimes the skiagrams may indicate a sh route but as the bed of the missi[illegible] cert

infected, no advantage except that of direct access is gained by a special incision. As the extraction [illegible] [illegible] with.

3. *Open wounds of the joint.* Cases in which the synovial cavity has been more or less widely opened without, or with only very slight damage of the articular surfaces. On admission the limb should be fixed in a suitable splint and the patient sent for X-ray examination in order to locate any foreign body and to ascertain to what extent, if any, the bones have been injured. On transference to the operating theatre the splint should not be removed until the patient has been anaesthetized.

*Excision of wounds.* The primary object must be to secure asepsis, and the surest and quickest way to obtain this is to excise the wound completely, if possible *en masse*, and with a scalpel. When this has been accomplished all used instruments, towels, and gloves should be discarded and a fresh outfit employed. All blood clot should be removed from the joint cavity, and for this purpose a Higginson's syringe previously sterilized by boiling and hot saline are used. Any piece of shrapnel in the joint must be sought for, if necessary making a second incision for its removal. Every effort to close the synovial membrane is now made, as on this depends the future function of the joint. This is not always possible, but if the suprapatellar pouch is loosened from its upper and anterior connexions and pulled downwards, enough tissue will frequently be found to accomplish this. Draining of the external wound

for twenty four to forty eight hours *down to but not into*, the synovial cavity may be employed if there is doubt regarding sepsis On the completion of the operation the limb should be fixed in a Thomas s splint slightly flexed and should be kept under the supervision of the surgeon for a few days

4 *Cases showing extensive injury to the bones* The majority of cases showing extensive comminution of the bones or a T shaped fracture of the lower end of femur or upper end of tibia can rarely be saved and primary amputation is frequently ad visable The severe constitutional symptoms which follow septic absorption from the injured spongy bone make this type of wound particularly danger ous When a comminuted fracture of the patella has occurred the fragments should be removed *en masse* with the wounded soft tissues It is not advisable to leave a part of the patella even though its blood supply seems intact through its attach-ment [illegible]

encouraging late results reported on excision of fractured patella in civil practice the operation can be undertaken with increased confidence In some cases of injury to the lower end of femur or upper end of tibia it may be possible to perform resection As little bone as possible should be removed—only what is soiled and badly comminuted At the same time free drainage must be obtained At the end of the operation the joint should be packed lightly with sterile dry gauze to control oozing and the skin wound closed by a few interrupted sutures Two or three days later the pack is removed, and

if conditions are satisfactory, the wound is sutured without drainage

**Treatment at advanced units.** From what has *been said the necessity for complete fixation of the* joint, even if injury is only suspected, will be appreciated by all who have to handle such cases The regimental and field ambulance medical officers will contribute in no small measure to the ultimate fate of the joint by ensuring adequate and comfortable splintage, and by expediting the transference of the patient to the operating centre as soon as possible As the patient very frequently suffers a great deal of pain morphia should be freely given

**Treatment of case where suppuration has already occurred** Where treatment has been delayed for a few days on account of impossibility of evacuation or where in spite of surgical treatment septic arthritis develops the surgeon must realize that the problem is serious and the prognosis grave Attempts at drainage by the insertion of rubber tubes into the joint will almost certainly fail Adequate drainage by this method, even if followed by frequent flushings of the joint cavity with antiseptics is *impossible owing to the several* compartments formed by the contour of the bones, crucial ligaments and synovial fringes Long incisions on each side of the patella into the joint cavity should be made No drains or packs should be inserted the wound being covered by a simple dry dressing and the patient encouraged to move the joint voluntarily as soon after operation as possible Passive movements must not be undertaken This treatment was recommended by Willems and good results were obtained If in spite of this treatment, toxic symptoms persist a transverse or flap incision

should be made followed by resection or after free division of the lateral and cruciate ligaments by packing and fixing the joint in nearly full flexion in a specially made splint In some cases the question of amputation will have to be considered and we must be careful not to postpone this decision until too late The surgeon must always remember that his first duty is to save life and that the skill of the prosthesis manufacturer has deprived amputation of much of its dread and disability

**Wounds of other joints** *Shoulder joint* If the articular surfaces are shattered limited excision with free drainage preferably posterior should be carried out The arm is fixed in 60° abduction and 15° in front of the coronal plane by abduction frame or by a plaster of Paris spica In cases showing less extensive injury to bone treatment of the flesh wounds followed by adequate fixation will give good results even though the joint cavity has been opened and the escape of synovial fluid noted

*Hip joint* Owing to the extensive injury to surrounding soft tissues the shock accompanying injury to the hip joint was very frequently profound and the mortality rate was high Operation consists of the excision of the wound track and [illegible] head of the femur This

moderate abduction either in plaster or in an abduction frame

*Wrist and elbow joints* Limited excision is advisable in all severe cases where the bones have been shattered but where the main vessels and

nerves are intact In the hope of a firm ankylosis as little bone as possible should be removed, but even a 'flail' joint is better than an amputation The joint should be immobilized in the position of choice —dorsi flexion in the case of wrist joint, and at a right angle in the case of the elbow.

*Ankle joint and tarsal joints* Wounds of the foot and ankle joints frequently do badly on account of the difficulty in obtaining free drainage In some cases a modified resection of the injured bone may be successful, but if the injury is extensive it is better to perform amputation through the lower third of the leg

## CHAPTER VIII

# OTHER SPECIAL INJURIES

## I. THE VERTEBRAL COLUMN

SIMPLE fracture or fracture dislocation of the vertebral column, which may occur as the result of enemy action, will not be discussed at length apart from stressing the importance of care in handling and *transport* If there is a suspicion of vertebral column injury extensive examination should *not* be carried out The patient should be transferred to a stretcher with the least possible disturbance taking care to support the shoulders buttocks, and lower limbs If the cervical spine is involved the patient is to be placed on his back with a small pillow or roll of clothing placed under the neck and shoulders to maintain extension In thoracic or lumbar injuries the patient is placed face downwards, the upper part of the body being raised slightly on a pillow

**Gun-shot wounds of the spinal column,** accompanied by paralysis give rise to such an overpowering sense of hopelessness on the part of the surgeon that he may well be pardoned for tackling such a case in a half hearted manner He must remember, however, that the paralysis may be due to concussion and that complete recovery may eventually take place There are no sure signs to distinguish between paralysis due to concussion, and that due to irreparable damage of the cord, and therefore even a remote chance of the restoration of function must continually stimulate him t further endeavour Clean through and '

bullet wounds should be treated on the same lines as simple fractures Good antero-posterior and [illegible]

out by an expert neurologist

Operation on the vertebral column should be undertaken (1) if X-rays show displaced fragments of bone or the presence of a piece of metal in or near the spinal canal, (2) when symptoms of paralysis have developed a short time after the infliction of the injury, indicating that this may be due to pressure from blood-clot (symptoms of cord involvement coming on at a later date and due to inflammatory changes will not be relieved by operation), (3) when *pain due to pressure on nerve roots, is excessive.*

In cases suffering from lacerated shell wounds it is necessary to excise the track in order to ascertain the presence or otherwise of a cord lesion, even though clinically it is suspected If possible, the operation should be carried out under local infiltration anaesthesia This allows the patient to lie prone, eliminates respiratory difficulties, and markedly lessens haemorrhage A set laminectomy should be avoided the laminae can usually be nibbled away and all obstruction to the easy removal of fragments should be removed before any attempt is made to lift them out If this principle is not followed further injury to dura and cord will result If the dura has been opened, attempts should be made to close it but this is very often impossible Depending on the extent of the injury and the efficiency of the operation, the surgeon will decide whether it will be safe to suture the muscles

[illegible] cord by artificial

*After-care* The nursing and after-care of patients suffering from spinal injuries present peculiar difficulties, and these are aggravated in the presence of paralysis The greatest care must be taken to guard against two complications, namely, (1) pressure sores, and (2) cystitis

1 *Pressure sores* In spite of incessant care on the part of the most capable nursing sisters, pressure sores will develop in many cases The surgeon must see that the splint or plaster does not cause undue pressure at any one point, and he must be prepared to modify or even abandon this method of treatment if sores threaten to develop

2 *Cystitis* In spite of every care inflammatory changes in the bladder will take place in cases of spinal cord lesion as the result of the upset of bladder function It is the duty of the surgeon to try to control the infection and to prevent its spread to the kidneys The muscle of the bladder wall passes through various changes subsequent to the paralysis For the first few weeks it is flaccid and incapable of contraction Later there is some degree of muscular tone and reduction of bladder capacity, and finally there develops the stage of automatic and, of course, unconscious, evacuation,

by catheterization which should be repeated at in-

the last war, the fact that various methods of treatment were recommended at different times shows how unsatisfactory each was found to be

1 *Regular catheterisation* This is impossible during heavy fighting or at other times during transport Strict aseptic technique must be maintained, but in spite of this the repeated and unavoidable irritation of the urethral mucous membrane ultimately leads to a urethritis and cystitis

2 *Continuous catheterisation* This is carried out by an indwelling catheter which should not be placed in a urinal but connected to a bottle containing a weak antiseptic at the bedside by means of long rubber tubing Urinals are difficult to cleanse and disinfect and the danger of infection through the catheter is considerable The catheter should be changed every third or fourth day and the bladder washed out daily with weak antiseptic lotion Urethritis is an inevitable sequel

3 *Suprapubic cystotomy* A de Pezzer catheter

[illegible]

reliable meth[illegible] as undue distension of the bladder cannot take place Cystitis is inevitable, but can be controlled by lavage through the catheter and the use of sulphapyridine

4 *Manual compression of the distended bladder* is mentioned only to be condemned It is uncertain and dangerous

## II INJURY TO PERIPHERAL NERVES

The surgeon will be impressed by the number of cases in which, although the nerve is in the wound

track its continuity has not been interrupted Frequently it will be bruised and it is impossible to assess the degree of injury to the axis cylinders inside the sheath In such cases the nerve should not be touched leaving to future development the decision as to whether resection will be necessary or not When the —
it will often
together ar
three fine linen or silk sutures passed through the sheath No attempt at elaborate suture should be made the aim of the operation being to facilitate the finding of the nerve ends at the operation of nerve suture undertaken later when the wound has healed Reports from the Base indicated that in a few cases this simple procedure resulted in a restoration of function without further operation

## III INJURY TO THE MAIN ARTERIES

In war surgery the main blood vessels assume a more important role than they do in civil surgery Apart from the danger of immediate death from bleeding there are the most important questions of the vitality of the muscles the development of massive gangrene the spread of infection particularly of the gas gangrene type and the risk of secondary haemorrhage It is therefore essential that early in the treatment the possibility of injury to a big artery should be looked for In some cases it will be obvious from the position of the wound and from the history of excessive bleeding that injury to an important blood vessel has taken place In other cases bleeding will have stopped and the diagnosis is more difficult Absence of the pulse distal to the injury will often make one suspicious

but in the lower limb this test is not always conclusive Excessive cramp like pain and board like

injury, loss of heat and a stocking' anaesthesia will frequently be found In other cases the vascular lesion will be found only when the track is explored

The arteries which cause difficulty are (a) *the popliteal artery* When ligature of this vessel is called for the collateral circulation is so poor that, in the majority of cases gangrene develops within two or three days In cases where this does not occur, the ischaemic fibrosis of the leg muscles and the trophic changes in the foot are so extensive that the limb remains functionless and, later, amputation has to be carried out

(b) *Posterior tibial artery* Similar although less extensive changes such as those which result from injury to the popliteal artery follow occlusion of this vessel Owing

the accompanying

comitantly injured

field is obscured making ligation difficult and tedious

(c) *The gluteal artery* is frequently injured in penetrating wounds of the buttock Emerging from the pelvis above the pyriformis muscle, it immediately divides into a superficial branch which supplies the gluteus maximus and a deep branch which lies under the gluteus medius and again divides into two terminal branches It will be readily understood how difficult may be the control of haemorrhage in injury to this vessel, and, further-

more, the danger of death of the large muscles supplied by it, with accompanying gas gangrene, explains the apprehension with which the surgeon approached these cases, particularly in the early months of the last war

(*d*) *The femoral artery* Injury to the femoral artery may prove fatal within a few minutes from loss of blood, but if the haemorrhage is arrested, or, if the vessel is only partially divided the loss of blood may not be excessive After ligature of the femoral artery the collateral circulation is established fairly rapidly and efficiently so that if the

the profunda branch may take place apart from

these vessels does not present great difficulty, and the collateral circulation is good

(*f*) *Brachial artery* Injury to this artery is frequently accompanied by injury to the median and ulnar nerves The collateral circulation, established after ligation depends on the extent of injury to the surrounding parts but is often poor and the danger of gangrene is considerable

**Treatment.** Treatment consists of ligature of

were made to re establish the continuity of the divided vessel Silver tubes (Tuffier) and circular suture, when the divided ends could be brought

given for the establishment of a good collateral circulation Ligation of the accompanying vein in order to prevent the development of gangrene was advocated by many including the late Sir George Makins, whose great interest in and wide experience of the diagnosis and treatment of blood vessel injuries, and his widely recognized sound judgement compel the greatest respect and consideration The experience of one individual is so limited that an expression of opinion is unjustifiable, and only impressions can be recorded The writer did not feel that ligature of the accompanying vein was an important factor in the prevention of gangrene or of the spread of sepsis but in discussions on this point he was generally in a minority

**Contusion of arteries** When the track of a missile passes close to a vessel the wall may be bruised but not divided In those cases careful examination for pulsation distal to the bruised area should be made at operation as frequently the tunica intima and media will be found to be ruptured and intravascular clotting will have taken place The risk of secondary haemorrhage is very great, and resection of the affected segment should be undertaken at the primary operation If it is felt that the lumen is not completely occluded, it is better to leave the vessel intact so as to allow of the formation of a collateral circulation, and to inspect the vessel carefully at the first dressing, on the second or third day with a view to resection if the previous diagnosis is confirmed

**Secondary haemorrhage.** This usually occurs a week or more after injury, but is an ever-present danger so long as the wound is unhealed and sepsis is present It may occur as a sudden massive bleeding or a warning may be given by one or more small haemorrhages In either case treatment must be prompt and should consist of double ligature of the vessel at the site of injury This, in the presence of oedematous granulations, may be difficult, but should be done whenever possible Linen thread and silk are more reliable ligature [illegible]

appointing results, as haemorrhage is likely to recur as soon as the collateral circulation has become established In some cases, however, it may be the only means of stopping bleeding and therefore in these it must be carried out

# INDEX

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